AMENDMENTS TO THE SPECIFICATION

To correct the "BRIEF DESCRIPTION OF THE DRAWINGS" section consistent with the substitute Figures 2, 3, 4, 5 and 6, Applicant submits the following replacement page for page 8, line 1 through line 20:

FIG. 1 is an exemplary profile of the thrust versus time for an existing propellant rocket.

FIG. 2 ~~(A-E) is~~ is a flowchart used to derive the computer code showing a portion of the main routine of processing to subroutines and presentation.

FIG. 3~~(A-B) is~~ is a flowchart used to derive the computer code subroutine for the iterative process to calculate the coefficient in the equation for the rate of throat erosion.

FIG. 4~~(A-B) is~~ is a flowchart used to derive the computer code subroutine for the iterative process to calculate the reference burn rate and for producing the web burned array.

FIG. 5~~(A-B) is~~ is a flowchart used to derive the computer code subroutine for the iterative process to calculate the characteristic velocity and for producing the burn surface and thrust coefficient arrays.

FIG. 6~~(A-B) is~~ is a flowchart used to derive the computer code subroutine for the iterative process to calculate the burn surface modifier and for producing the burnback profile.

FIG. 7 is a burnback profile generated by the present invention for two MK 106 rocket motors.

FIG 8 is a graph of thrust versus time for MK 106 rocket motors showing test firing results and modeled predictions using the present invention.

FIG 9 is a burnback profile generated by the present invention for three MK 106 rocket motors.

FIG 10 is a graph of thrust versus time for MK 106 rocket motors showing test firing results and modeled predictions using the present invention and including a test firing at the same temperature used by the model.

To correct the Detailed Description section consistent with the substitute Figures 2, 3, 4, 5 and 6, Applicant submits the following replacement paragraph for page 10, lines 5-10:

~~FIGs. 2A-2E are printouts of~~ FIG. 2 is a flowchart used to derive the main routine computer code, which begins by importing a data file containing the above described data: web thickness, propellant weight, propellant density data, initial throat diameter, thermal expansion coefficient, temperature sensitivity coefficient and pressure exponent data, and test firing data.

As seen in ~~FIG. 2A, the code~~ FIG.2, the flowchart verifies the presence of required data elements and calls upon the subroutine calculations of the present invention.

To correct the Detailed Description section consistent with the substitute Figures 2, 3, 4, 5 and 6, Applicant submits the following replacement paragraphs for page 12, lines 1-18:

As shown ~~in~~ derived from the relevant portions of ~~code in FIGs. 3A and 3B~~ the flowchart of FIG. 3 ~~in FIGs. 3A and3B~~ , the subroutine designated as Private Sub SetErosion varies the coefficient *a* over a range of values and calculates the array of incremental throat radii, repeating the process until the final throat radius matches the final throat radius input by the user. In addition to the value for throat radius, the program can be designed to work with other dimensions of the throat, such as diameter or area. The Private Sub SetErosion subroutine uses the expression for the incremental throat radius, given by equation #2, in equation #3, including the selected value for *a* and solves equation #3 for each time increment to produce a throat area profile at the test firing temperature.

The variables set forth in the Private Sub SetErosion subroutine ~~of FIGs 3A and 3B are~~ derived from FIG. 3 is as follows:

Incremental chamber pressure at time increment "*i*" - PressIn (i)

Time increment "*i*" - TimeIn (i)

Incremental throat area - AtIn (i) and This Value

Given the foregoing, the main program code then calls a second subroutine as ~~shown in FIGs. 4A and 4B and~~ derived from FIG. 4 and is designated Sub SetBurnRate, which varies the reference burn rate in an iterative process until the total linear web burned at the end of the firing matches the user input value for web thickness.

To correct inadvertent, typographical errors and consistent with the substitute Figures 2, 3, 4, 5 and 6, Applicant submits the following replacement page for page 13, line 1 through line 19:

$$\dot{r}_i = \dot{r}_{ref}\left(\frac{P_i}{P_{ref}}\right)^n$$ [Equation #4]

Where:

$\dot{r}_{ref}$ = Burn rate at reference pressure and motor conditioning temperature

P_{ref} = Reference pressure (model uses 1500 pounds per square inch)

n = Pressure exponent input by the user

The total linear web burned as of time increment "*i*" is given by the equation:

$$wb_i = wb_{i-1} + \left(\frac{\dot{r}_{i-1} + \dot{r}_i}{2}\right)(t_i - t_{i-1})$$ [Equation #5]

Where: wb_i = Total linear web burned as of time increment "*i*"

The Private Sub SetBurnRate subroutine ~~of FIGs. 4A & 4B~~ <u>derived from the flowchart of FIG.4</u> uses the expression for the incremental linear burn rate given by equation #4 and solves equation #5 repeatedly, varying the reference burn rate in an iterative process until the total linear web burned at

the end of the firing matches the user input value for web thickness. The selected reference burn rate is the correct

To correct inadvertent, typographical errors and consistent with the substitute Figures 2, 3, 4, 5 and 6, Applicant submits the following replacement paragraphs for page 14, line 5- last line of page 14:

The variables set forth in the foregoing equations are indicated in the code ~~of FIGs. 4A & 4B~~ derived from the flowchart of FIG.4 as follows:

Burn rate at reference pressure and motor conditioning temperature - rref

Reference pressure - PREF

Pressure exponent - nexp

Total linear web burned at time increment "*i*" - WburnIn(i) and ThisValue

Incremental linear burn rate - brate

Given the foregoing, the main program code then calls a third subroutine as ~~shown in FIGs. 5A & 5B~~ derived from the flowchart of FIG. 5 and designated Private Sub SetCStar which calculates the mass flow values and varies the characteristic velocity in an iterative process until the propellant weight burned at the end of the firing matches the actual value input by the user for the propellant weight.

The mass flow at a time increment "*i*" is a function of the incremental chamber pressure and the incremental throat area. The mass flow at a time increment "*i*" is given by the equation:

$$\dot{m}_i = \frac{P_i A t_i g}{C^*} \qquad \text{[Equation \#6]}$$

To correct inadvertent, typographical errors, Applicant submits the following replacement paragraphs for page 15, line 6- last line of page 15:

The burn surface at time increment "*i*" is given by the equation:

$$S_i = \frac{\dot{m}_i}{\dot{r}_i \rho}$$ [Equation #7]

Where: ρ is propellant density at firing temperature

The method assumes a default value of 0.065 for the propellant density although the user can input another value for the propellant density in the original data set.

The propellant weight burned as of a time increment "*i*" is given by the equation:

$$Pb_i = Pb_{i-1} + \left(\frac{\dot{m}_{i-1} + \dot{m}_i}{2}\right)(t_i - t_{i-1})$$ [Equation #8]

To correct the Detailed Description consistent with the substitute Figures 2, 3, 4, 5 and 6, Applicant submits the following replacement paragraphs for page 16, lines 8- 20:

The Private Sub SetCStar subroutine ~~of FIGs. 5A and 5B~~ as derived from the flowchart of FIG.5 uses equation #6 to provide the incremental mass flow values, with the characteristic velocity given an initial default value of 60,000. The model solves equations #4, #7, #8 and #9 for each time increment, repeatedly, varying the characteristic velocity in an iterative process and selecting the value of characteristic velocity which gives the propellant weight burned, given by Equation #8, at the end of the firing, matching the actual value input by the user for the propellant weight. The same subroutine also solves equations #7 and #9, for each time increment, using the selected value for characteristic velocity, to produce an array of burn surface and thrust coefficients, respectively for each time increment.

The variables set forth in the third subroutine Private Sub SetCStar ~~at FIGs. 5A and 5B~~ as derived from the flowchart of FIG.5 are represented as follows:

Characteristic velocity - CS

Burn surface at time increment "*i*" - BsurfIn(i)

To correct the Detailed Description consistent with the substitute Figures 2, 3, 4, 5 and 6, Applicant submits the following replacement paragraph for page 17, lines 13-16:

Given the foregoing, the main program code then calls a fourth subroutine as ~~shown in FIGs. 6A and 6B~~ derived from the flowchart of FIG. 6 and designated Private Function GenerateOutput, which calculates a prediction of the ballistics performance of the rocket motor at any given temperature, including those at which no test firing data is available.

To correct inadvertent, typographical errors, Applicant submits the following replacement paragraph for page 18, line 16- last line of page 18:

The incremental burn rate is temperature dependent and, for the output temperature, is calculated, using Equation #4, with the temperature dependent variables adjusted, as follows

$$\dot{r}_{out_i} = \dot{r}_{ref_{out}} \left(\frac{P_{i-1}}{\mathrm{P}_{ref}} \right)^{n_{out}}$$

[Equation #12]

Where: n_{out} is the pressure exponent at the output temperature...

To correct inadvertent, typographical errors and consistent with the substitute Figures 2, 3, 4, 5 and 6, Applicant submits the following replacement paragraphs for page 19, line 1- last line of page 19:

$$\dot{r}_{refout} = \dot{r}_{refin} \times e^{\sigma_p (T_{out} - T_{in})}$$

The temperature sensitivity coefficient, σ_p , is input by the user but has a default value of 0.001.

The Private Function GenerateOutput subroutine ~~of FIGs. 6A and 6B~~ as derived from the flowchart of FIG.6 defines variables as follows:

Reference burn rate at the output temperature - OutBurnRate

Reference burn rate at the input temperature - InBurnRate

e - E

Temperature sensitivity coefficient - SigmaP

Output temperature - OutTemp

Input temperature - InTemp

The values for characteristic velocity and the rate of throat erosion are applied to the equations which determine the relationship of the variables, using the values for the output temperature to predict the ballistics performance of the rocket motor at the output temperature. Equation #7 can be expressed as follows:

$$\dot{m}_{outi} = \dot{r}_{outi} S_{outi} \rho_{out}$$ [Equation #13]

Where: ρ_{out} = Propellant density at the output temperature

To correct inadvertent, typographical errors, Applicant submits the following replacement paragraph for page 20, line 14- last line of page 20:.

The expression for the mass flow, given by equation #13, is substituted into equation #6, which is rewritten as follows:

$$P_i = \left(\frac{\dot{m}_{outi} C^*}{At_{outi} g} \right)$$ [Equation #15]

To correct the Detailed Description consistent with the substitute Figures 2, 3, 4, 5 and 6, Applicant submits the following replacement paragraph for page 21, lines 1-11:

The variables set forth in the Private Function GenerateOutput subroutine ~~of FIGs. 6A and 6B~~ as derived from the flowchart of FIG. 6, are as follows:

Linear web burned at increment "*i*", at output temperature - WburnOut (i)

Web depth at input temperature - InWebDepth

Web depth at output temperature - OutWebDepth

Incremental burn surface at output temperature - BsurfOut (i)

Incremental chamber pressure at output temperature - PressOut (i)

Incremental throat area at output temperature - AtOut (i)

Initial throat area - AtO

Final throat area - AtF

Final throat area at output temperature - AtFOut

To correct the Detailed Description consistent with the substitute Figures 2, 3, 4, 5 and 6, Applicant submits the following replacement paragraph for page 22, lines 4-13:

Equation #9 is rewritten to give an expression for thrust, as follows:

$$F_{out_i} = c_{f_{out_i}} P_{c_i} At_{out_i}$$

[Equation 17]

The variables set forth in the computer model, as ~~shown in FIGs. 6A and 6B~~ derived from the flowchart of FIG. 6 are as follows:

Incremental thrust at output temperature - ThrustOut (i)

Output temperature - trefout

Input temperature - trefin

To correct the Detailed Description consistent with the substitute Figures 2, 3, 4, 5 and 6, Applicant submits the following replacement paragraph for page 23, lines 1-15:

The subroutine solves Equations #10 through #18 for each integer numbered increment and also solves Equation #8 for total propellant weight burned. Equation #12 is dependent on the pressure, at the output temperature, for the preceding increment, so the process begins with a default pressure of 14.7, for the increment i - 1, and writes the pressure derived from Equation #15, into each succeeding calculation of Equation #12. The subroutine solves the referenced equations, repeatedly, in an iterative operation, varying the burn surface modifier and selecting the burn surface modifier which produces a total propellant weight burned, from Equation #8, matching the user input propellant weight. The subroutine uses the selected burn surface modifier to generate the burnback profile, thrust coefficient versus time, pressure versus time and thrust versus time, all for the user selected firing temperature. The burnback profile and thrust versus time data are output in graph form, as shown in FIGs. ~~6A and 6B~~ 7-14. Burn surface profiles, for various rocket motors, which the method has generated appear as FIGs. 7,9,11 and 13. From this information, a complete analysis of the ballistics performance of the rocket motor can be predicted, for a firing temperature selected by the user, without the burden and expense of test firing the rocket motor at the selected temperature.